CARO ANALYTICAL SERVICES

RemTech 2016

The Chemistry of Change: Regulatory & New Technology Update

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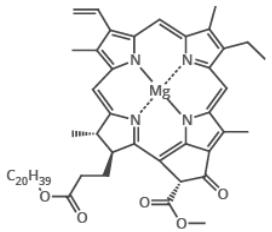
ANALYTICAL SERVICES

THE CHEMISTRY OF THE COLOURS OF AUTUMN LEAVES

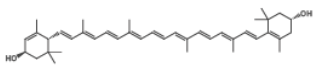
CHLOROPHYLL



CHLOROPHYLL A
A type of chlorin

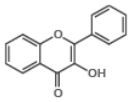
Chlorophyll is the chemical that gives plant leaves their green colour. Plants require warm temperatures and sunlight to produce chlorophyll - in autumn, the amount produced begins to decrease, and the existing chlorophyll is slowly broken down, diminishing the green colour of the leaves.

CAROTENOIDS & FLAVONOIDS

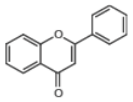


LUTEIN
A type of carotenoid

Carotenoids and flavonoid pigments are always present in leaves, but as chlorophyll is broken down in the autumn their colours come to the fore. Xanthophylls, a subclass of carotenoids, are responsible for the yellows of autumn leaves. One of the major xanthophylls, lutein, is also the compound that contributes towards the yellow colour of egg yolks.

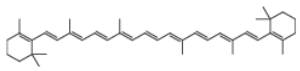


FLAVONOL
(general structure)



FLAVONE
(general structure)

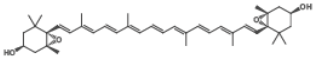
CAROTENOIDS



ß-CAROTENE
A type of carotenoid

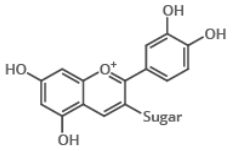
Carotenoids can also contribute orange colours. Beta-carotene is one of the most common carotenoids in plants, and absorbs green and blue light strongly, reflecting red and yellow light and causing its orange appearance. It is also responsible for the orange colouration of carrots.

Carotenoids in leaves start degrading at the same time as chlorophyll, but they do so at a much slower rate; beta-carotene is amongst the most stable, and some fallen leaves can still contain measurable amounts.



VIOLAXANTHIN
A type of carotenoid

ANTHOCYANINS & CAROTENOIDS



ANTHOCYANINS
(general structure)

Unlike the carotenoids, anthocyanin synthesis is kick-started by the onset of autumn - as sugar concentration in the leaves increases, sunlight initiates anthocyanin production. The purpose they serve isn't clear, but it's been suggested that they help protect the leaves from excess light, prolonging the amount of time before they fall.

LYCOPENE
A type of carotenoid

Overview

1. Background:
   What does this mean for the environmental testing industry?
2. Revisions to Existing Standards
3. New and Emerging Compounds
4. Industry Response
5. New Technology

CARO Highlights

In operation for nearly 30 years

Locally owned and operated with labs in:

- Richmond BC (head office)
- Kelowna BC
- Edmonton AB

Technical and Client Service Leadership

- Personalized Service / Strong Relationships
- Attention to Quality / P.Chem. Designations
- Online Offerings: ClientConnect / EnviroChain / Store

***C**aring **A**bout **R**esults…. **O**bviously*

WHAT WE DO

1. **Contaminated Site** – *3rd Largest Lab in BC*
   - Hydrocarbons, PAHs, VOCs, Metals, Phenols, PCBs, Metals, Class 2 Landfill

2. **Soil Vapour** – *First Accredited in BC, Market share*
   - VOCs, PAHs, Equipment Rental, Training, Project Planning

3. **Environmental Monitoring**
   - Biota/Tissues - Metals, PAHs, lipid
   - Low Level DLs –metals, organics, nutrients, anions
   - Aquatic Toxicity – chronic and acute
   - Pesticide, Herbicides , DDAC, Hormones, Priority Pollutants

4. **Microbiology** – *BC's Largest Private Sector Water Lab*
   - Drinking water, Composts, In-Situ Remediation (BARTs)

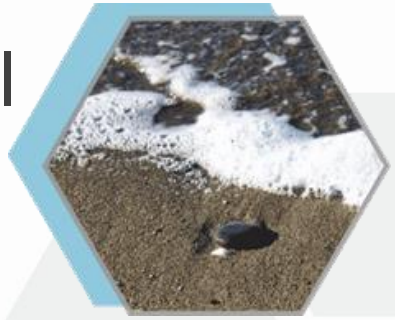
What Does this Mean?

At least **1/3** of CARO's analytical work is related to the BC Contaminated Sites (CSR) regulation

Main CSR Tests

Three parameter groups represent ~80% of CSR testing:

- Semivolatiles: EPH, PAH, L/HEPH (30%)
- Metals (30%)
- Volatiles: VH, BTEX, VOC (20%)
- Others: Phenols, PCB, Salt, General Parameters (20%)



Standards and Guidelines

Continually Updated and Expanded

Primary:

- BC CSR – Schedules 4, 5, 6, 7, 9, 10, 11
- BC HWR – MLEP, Waste Oil Content, etc.
- AB Tier 1 and other provincial jurisdictions
- CCME CEQG – Water, Soil, Sediment (+emerging)

Secondary:

- BC WQG – Approved, Working, Draft (Drinking Water)
- Canadian DWQG
- CEPA Disposal at Sea – Metals, PAHs, PCBs

New Guidelines Released: Alberta Tier 1 and Tier 2 (2016)

&

Stage 10 Amendments to BC Contaminated Sites Regulation

What Does this Mean?

Draft Discussion Document: For Stakeholder Consultation
Comment Period Closes: Aug. 28, 2015

CSR OMNIBUS UPDATING: Proposed Amendments to Schedule 5 Environmental Protection Standards

Author: Remi Odense/Glyn Fox **Date:** June 2015

Summary of Proposed Updates for 2015/2016 Stage 10 amendment to CSR

Where time, resource and data constraints allow, the ministry proposes to:

1. Update, to incorporate new science, the CSST, 1996 [1] protocol in respect to the derivation of environmental protection, soil invertebrate and plants matrix soil standards.
2. The updated protocol to include derivation of soil invertebrate and plant soil standards for Wildlands (WL) and High Density Residential (RL_{HDR}) land uses.
3. Repeal the existing CSR Schedule 5 and incorporate Schedule 5 listed substances into a proposed new single schedule of consolidated Schedule 4, 5 and 10 soil standards (i.e. proposed new Schedule "X").
4. For the existing prescribed substances of Schedule 5, update the soil invertebrate and plant standard in accordance with the proposed updated CSST 1996 [1] protocol.
5. For substances which have had new CCME soil environmental protection guidelines derived since 1995, develop soil invertebrate and plant standards in accordance with the proposed updated CSST 1996 [1] protocol.
6. For substances currently listed in Schedule 4, derive new soil invertebrate and plant standards in accordance with the proposed updated CSST 1996 [1] protocol .
7. For existing Schedule 4 prescribed substances, where toxicological data is insufficient to calculate the two mandatory components of Schedule 5 matrix soil standards (i.e. Human Health Protection – intake of contaminated soil and Environmental Protection – toxicity to soil invertebrates and plants), incorporate the existing Schedule 4 soil standard as the mandatory matrix standard and footnote accordingly.
8. Calculate in accordance with the original CSST, 1996 [1] protocol, livestock ingesting soil and fodder matrix soil standards for substances for which new matrices are proposed.
9. Derive for some currently non-prescribed substances (i.e. emerging contaminants of concern, PFOS, selenium, etc.) new environmental protection matrix soil standards.
10. Due to toxicity data limitations, the ministry does not propose to derive soil invertebrate or plant standards for substances currently prescribed in CSR Schedule 10.

What Does this Mean?

New Guidelines Released: Alberta Tier 1 and Tier 2 (2016)

Alberta Environment and Parks has released revisions to the following documents:

Alberta Tier 1 Soil and Groundwater Remediation Guidelines
Alberta Tier 2 Soil and Groundwater Remediation Guidelines

The guidelines are available at:http://aep.alberta.ca/lands-forests/land-industrial/inspections-and-compliance/alberta-soil-and-groundwater-remediation-guidelines.aspx

Although the 2016 editions of the Alberta Tier 1 and Tier 2 guidelines may be used immediately, they formally come into effect on May 1, 2016. Alberta Environment and Parks and the Alberta Energy Regulator will continue to accept applications for reclamation certificates and remediation certificates that are compliant with the 2014 edition of the Alberta Tier 1 and Tier 2 guidelines provided laboratory analytical data reports from Phase 2 environmental site assessments or confirmatory sampling events are dated on or before April 30, 2016. Laboratory analytical data reports dated May 1, 2016 or later must be compliant with the 2016 edition of the Alberta Tier 1 and Tier 2 guidelines.

A summary table showing which guidelines have changed is attached.

Where revised guidelines are a result of revisions to Tier 1 and Tier 2 input parameters, these changes have been made in Appendix C of the Tier 1 document and Appendix A of the Tier 2 document.

In addition to editorial corrections, the following changes have been made to the text:

Sections 2.3.4 and 5.2.3 in the Tier 1 guidelines and Section 2.3.3 in the Tier 2 guidelines have been revised to include the implementation of the *Subsoil Petroleum Hydrocarbon Guidelines for Remote Forested Sites in the Green Area*.

Section 5.2.4 in the Tier 1 guidelines has been revised to clarify the relationship between non-carcinogenic PAHs and petroleum hydrocarbon fractions 1 to 4.

For questions, please contact:

Alberta Environment and Parks
land.management@gov.ab.ca

http://www.pchem.ca/posts/60

BCELTAC

British Columbia Environmental

Laboratory Technical Advisory Committee

- Industry partnership with the BCMOE
- CARO involvement 10+ years
- Method authorship:
  - Prescribed: strict adherence required, e.g. SALM
  - Performance-based: deviations allowed, e.g. VH

Standardized provincial methods = laboratory alignment

Mission

1. Advance, encourage, and facilitate continuing technical excellence in all aspects of environmental laboratory practice within BC
2. Act within an expert capacity to provide advice and guidance in the development and maintenance of sampling and laboratory methods
3. Research, promote and champion the development of new and improved science based laboratory analytical methods
4. Foster, support and facilitate common accepted standards for laboratory practice and performance
5. Promote co-ordination and cooperation between and among the ministry, concerned stakeholders, and private laboratories
6. Provide expert opinion and advice concerning environmental testing practices within British Columbia
7. Act as a primary resource to assist the ministry to facilitate effective and coordinated communication with environmental laboratories and concerned stakeholders within British Columbia.

Methods

Parameter Group	BC	Canada
Hydrocarbons – Gasoline Range	VH	PHC F1 *
Hydrocarbons - Diesel and Motor Oil Range	EPH (L/HEPH)	PHC F2-F4 *
Metals in Soil	SALM	N/A
Total Metals in Water	Standardized Digestion	N/A
Soil Vapour (Volatiles)	YES (Multiple)	N/A
Emerging Contaminants of Concern	In Progress	N/A

* CCME PHC Method is 15 years old

Influence

CCME Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment: Volume 4 Analytical Methods (2016)

Follows BC (and ON) Lead:

- References the BC Environmental Lab Manual
- Holding Times for Unpreserved NH3, NO2, NO3, PO4, TP, TN, Turbidity increased to 3 days
- Mercury in Water: preservation with HCl in Glass
- VOC in Soil: field preservation with MeOH or Hermitic samplers

Key Initiatives

Recent:

- 2008-2009: Soil Vapour – Reviewed CSR Schedule 11 and Developed Section H of the BC Lab Manual
- 2009-2012: Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators (updated 2016)

Present:

- BC CSR Omnibus update – significant involvement
- Selection of Leachate methods for use under CSR Protocol 2
- Subcommittee to review Microbiology and Toxicology Methods

Stage 10 CSR Engagement

August 2015 Letter to BCMOE: BCELTAC Recommendations and Comments *18 Recommendations*

- Request for Advance Input Regarding Reduced Numerical Standards and New Standards (granted)
- Continue with Use of BC Hydrocarbon Parameter Regime (granted)
- Clarify units, e.g. Ammonia and Salinity (granted)
- Define Chlorophenol Parameters for water matrix (granted)
- Redefine Total PCB to include 9 Aroclors
- Define Requirement for Hardness Calculation (deferred)
- Address Issues with Salt Standards for Peat Samples (deferred)

Stage 10 CSR Involvement

Review of Proposed Standards (Complete)

- BCELTAC Members bound by Confidentiality Agreement
- Substance Naming Standardization
- Detection Limit Checking – can Labs achieve lowest standards?

Literature Review (In Progress)

- Is there a suitable reference method for the new substances?
  - No: Develop new BC Lab Manual method
  - Yes: Define key requirements and refer to an existing reference method
- Do revised standards require modification to existing method?

Goal: All CSR Substances are referenced in the BC Lab Manual

What does this mean for BC Labs?

BCELTAC:

- BCMOE to provide proposed standards in Dec/Jan
- Ensure that standard is achievable by multiple labs
- May need to revise or create new provincial method

Individual Labs:

- May need to revalidate existing method
- May validate new method(s) to meet demands
- Will need to update their Scope of Accreditation

Detection vs Reporting Limits

Method Detection Limit (MDL):

Statistically derived (best case scenario)
– *high uncertainty* (>100%)

Reporting Limit (MRL, RL, RDL):

Based on Reality (typically 2-3x MDL)
– *medium uncertainty* (<100%)

GOAL: Default RL below CSR Standard, ideally 5x lower - allows for moisture corrections, interferences and *low uncertainty* at the concentration of the standard (<50%)

A lower MRL is not necessarily better

Case Study – BTEX in Soil

New field preservation requirements (2014)

- Most labs/clients are using Methanol (target 2:1 ratio to soil)
- Methanol is a restricted substance for air transport
- Requirements must be met, otherwise RLs are compromised
- Example: Benzene (MRL = 0.02 mg/kg, Standard = 0.04 mg/kg)

Sample Wet Wt.	% Moisture	Ratio	Multiplier	MRL
Too Low (3 g)	10	10:3	1.9	0.04 =
	40	11:2	3.1	0.06 ×
Optimal (5 g)	10	10.5:4.5	1.2	0.02 ✓
	40	12:3	2.0	0.04 =
Too High (10 g)	10	11:9	0.6 *	0.02 ✓
	40	14:6	1.2 *	0.02 ✓

** Methanol must be added in lab to meet minimum ratio of 1.5:1 (wet)*

Leveraging Technology

Industry Pressures:

- Pricing
- Quicker Results
- Value added services (or not)

Technological Gains:

- Minimizing Errors – Integrated and Centralized LIMS
- Delivering on Commitments - Real-time Instrument Capacities
- Increased Economies of Scale - Larger Batches, Centralization
- Lower Costs - Increased Automation, Newer Instrumentation
- Simplified Methods – lower pricing, smaller volumes, faster TATs

Revisions to Existing Standards

Why? Based on most recent science, alignment with other jurisdictions (CCME, EPA)

1. Standard is adjusted:
   - –Possibly lowered: PAHs, VOCs, Metals
   - –Raised: Lab would likely leave method (MRL) as-is

2. Standard is redefined:
   - –Total Non-Chlorinated Phenols → Individual Standards
   - –Total PCB: Four Aroclors → Nine Aroclors
   - –PAH: Benzo(b)fluoranthene and Benzo(k)fluoranthene combined

Emerging Contaminants of Concern

Broadly defined as *any synthetic or naturally occurring chemical or any microorganism* *that is not commonly monitored in the environment but has the* *potential to enter the environment and cause known or suspected adverse ecological and(or) human health effects*.

Examples:

- Alkylated PAHs: C3-fluoranthenes/pyrenes
- Antimicrobials: Triclosan
- Endocrine Disruptors: Bisphenol A
- Flame Retardants: PBDEs
- Pharmaceutical and Personal Care Products

How do Emerging Contaminants Differ?

Chemical properties

- Many isomers and degradation products
- Higher solubility in water
- Ubiquitous – prone to contamination

Economics

- Expensive instrumentation & standards ➔ costly
- Can be time consuming ➔ higher TATs
- Lower demand ➔ costly

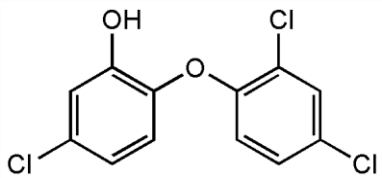
Contaminated Sites vs. Environmental Monitoring

Examples of Priority Compounds

Antimicrobials (Triclosan, Triclocarban)

- Usage: antibacterial soaps, medical industry
- Problem: promote resistance to antibiotics
- Instrumentation: LC-MS/MS (0.05 µg/L) ✓

Hormones (17a-ethinylestradiol):

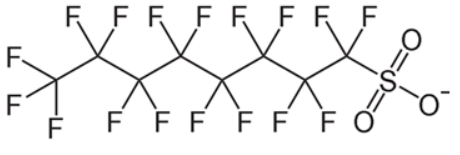


- Usage: contraceptive
- Problem: endocrine disruptor
- Instrumentation: LC-MS/MS (0.002 µg/L) ✓

Examples of Priority Compounds

Alkylated PAHs

- Usage: none (PAH degradation products)
- Problem: bioaccumulation (worse than parent PAHs)
- Instrumentation: GC-MS (<1 µg/L) or GC-MS/MS ✓



Others:

- Perfluorinated Substances (PFOS) – LC-MS/MS
- Detergents (Nonylphenol, Octylphenol) – LC-MS/MS
- Polybrominated Diphenyl Ethers – High Resolution GC/MS

New Technology Equipment

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New Technology Research

CARO News

Veterinary Antibiotics in Agricultural Runoff in the BC Watershed

Posted on May 16, 2016

Did you know that more than half of all antibiotics used in the world are used on farm animals? Though intended to improve the health and well being of livestock, these veterinary antibiotics are making their way into the environment through agriculture runoff, causing environmental and potential human health issues. At CARO, we are constantly working on ways to provide our clients a better understanding of emerging contaminants of concern in BC's Lower Mainland and across Western Canada.

This is the second recent post on the topic since focusing attention soil and water samples for antibiotics – read our first post about our expanded pharmaceuticals and personal care products testing capabilities here.

New Technology Research

The CARO Approach

For this project, water and sediment samples were collected at various locations throughout the agricultural area of the lower Sumas watershed. Using LC QQQ and EPA methodology, we tested for 24 antibiotics from 5 separate compound classes currently approved for use in agricultural practices.

Name	Formula	Class	Veterinary Use
Monensin	C36H62O11	Ionophores	Cattle, chicken, turkey
Chlortetracycline	C22H23ClN2O8	Tetracyclines	Chicken, turkey, swine, cattle, sheep
Tylosin	C46H77NO17	Macrolides	Cattle, swine, chicken
Lincomycin	C18H34N2O6S	Lincosamides	Sheep, chicken, duck, goat, turkey, cattle
Sulfadimethoxine	C12H14N4O4S	Sulfonamides	Cattle, piglet, horse

New Technology
Environmental Sampling

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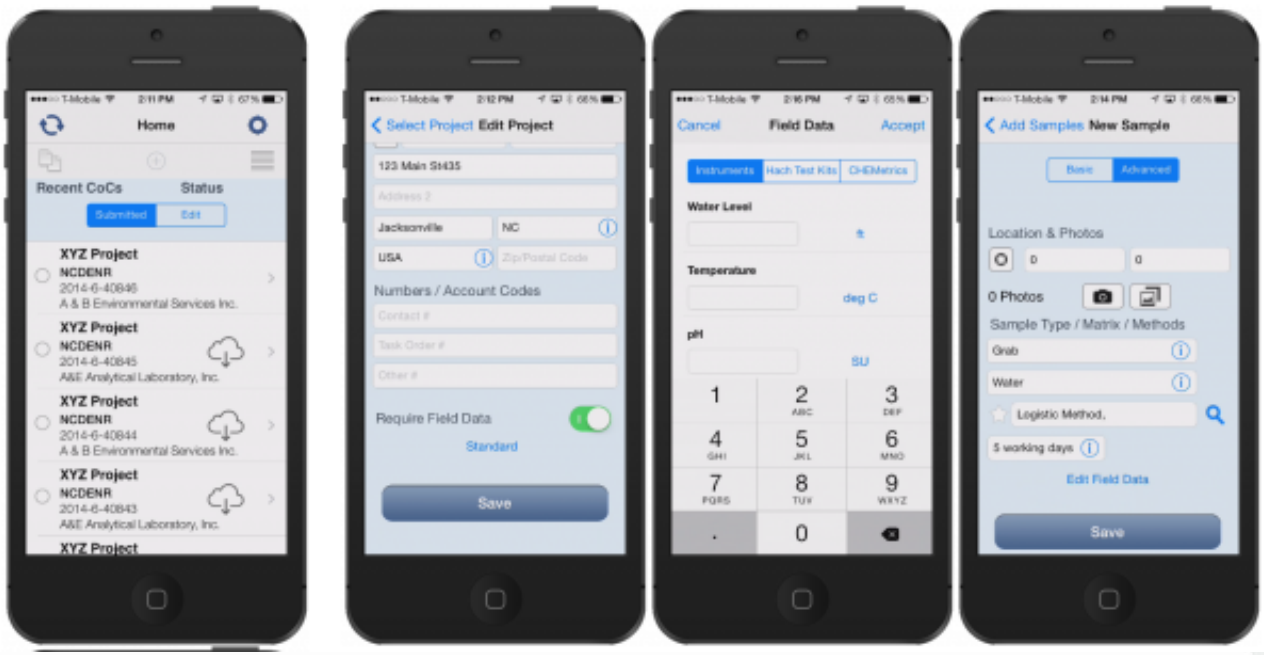
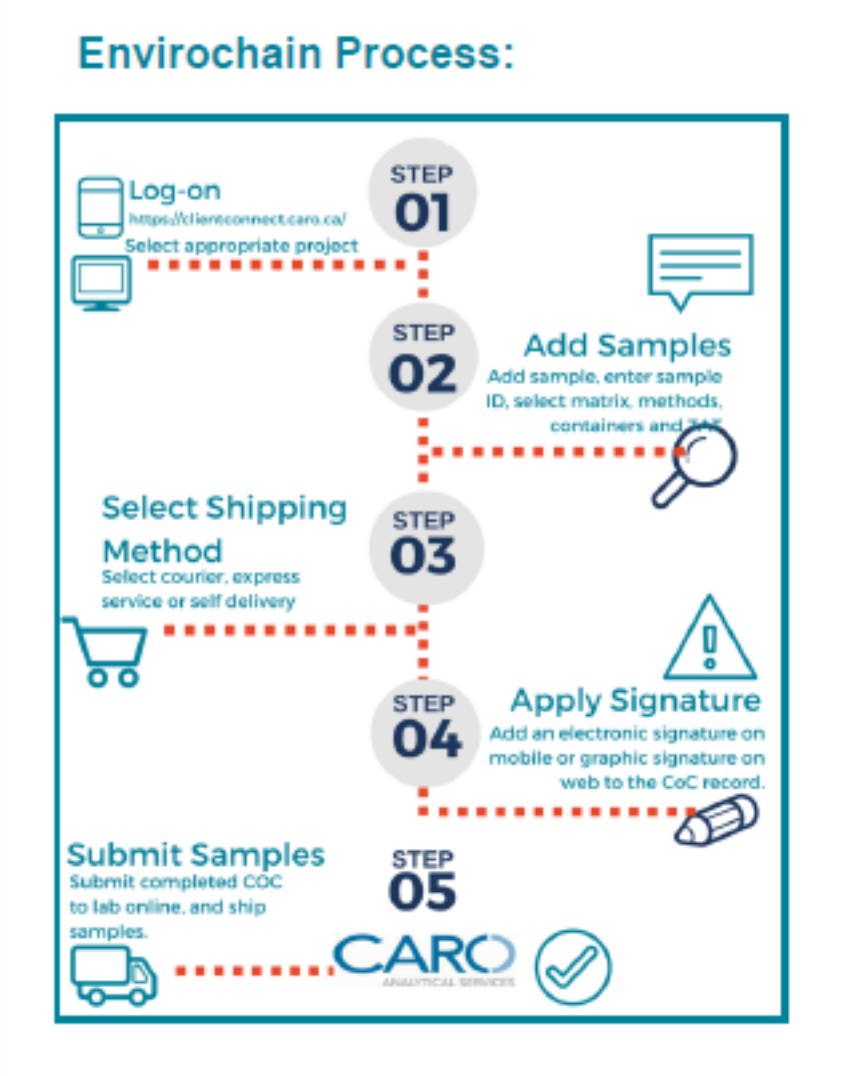
New Technology Environmental Sampling

Seven cool features in EnviroChain to make your environmental sampling event more enjoyable

by Jim Young | Sep 24, 2015 | Environmental Topics | 0 comments



Envirochain



CARO Online

Benefits of using CARO Online:

- **24/7 Access** to Data
- Eliminate transcription errors
- Use previous samples as **templates**
- Submission and Data **History** in one place
- **Immediate** Notification to the lab
- **Paperless** Submissions

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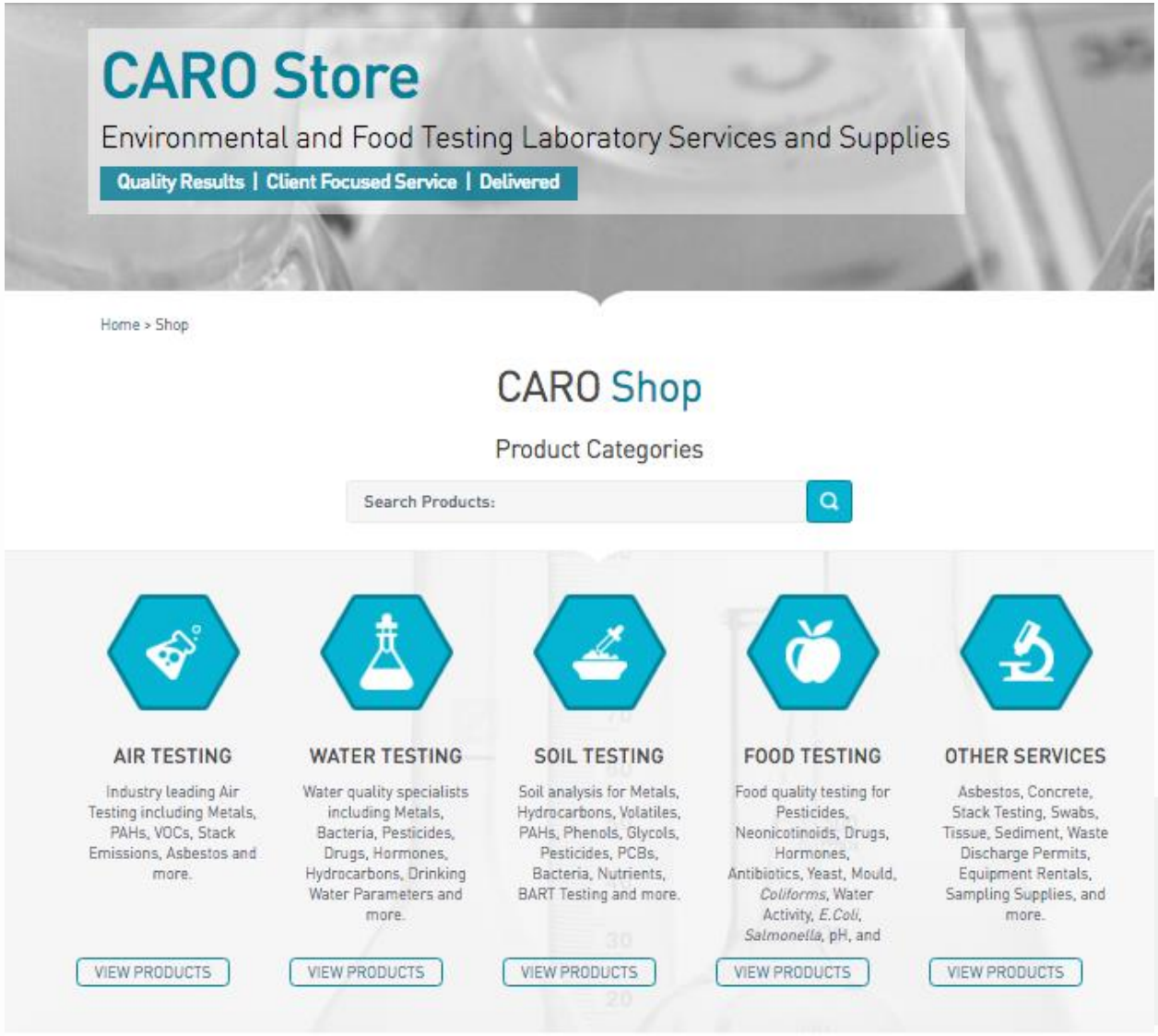
Online Store



The Future

New regulations, e.g. emerging contaminants of concern

- More samples analyzed by LC-MS/MS and GC-MS/MS -> more expensive and time-consuming, but provides more detailed info

Mobility:

- Field Testing - Increased availability and lower cost (limitations)
- Remote sample login and project management

External:

- Accreditation requirement?
- Greater role for P.Chems?

Reporting and Data Management:

- Automated evaluation of analytical data against regulations
- Reporting everything or only what is requested?
- Online data repositories, public access to metadata for mining trends?

Questions?

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I couldn't resist...